THURSDAY, NOVEMBER 21, 1878

MATHEMATICS AT CAMBRIDGE.

THE Cambridge Examination for Mathematical Honours has for a long time enjoyed a high reputation, especially among Cambridge men, who have been accustomed to point to it as the model of what an examination should be. The credit thus claimed has been in past times more or less deserved, but to what extent it is so now is a question on which there may be variety of opinion. Like every other institution, the practical usefulness of which depends upon the ease with which it can adjust itself to external conditions, the Tripos examination must undergo changes to meet corresponding changes from the outside; and there may come a time when the external conditions operate so powerfully that mere modifications are insufficient, and when the changes made must be both radical and extensive. The old Tripos system has recently been put to a severe strain, and it is admitted on all hands that the result has proved unsatisfactory. We propose to inquire into the causes which have brought this about, and to discuss the measures by which it is hoped the evil will be met.

It may be laid down as a fundamental axiom that a university honours examination should be in harmony with the studies of the candidates, and that it should be reasonable in its demands upon them. What the very best students may be expected to answer after faithful work during their undergraduate course should clearly be taken as a guide in fixing a superior limit to the number and difficulty of the questions. Nor should this estimate be pitched too high, because there are other subjects of interest and study besides mathematics, in which it is desirable that even the best of young mathematicians should engage, and an education based on mathematics alone must necessarily be defective.

If we accept these propositions we must admit that the estimate of what is reasonable towards the candidates was very different fifty years ago to what it is now. One cannot help looking back with regretful eyes on the Tripos questions of that time, so remarkable for their simplicity and elegance, as well as for the happy appreciation of the degree of difficulty such questions should possess. The questions of more recent times, although they are often to be admired from an æsthetic point of view, are in many instances far beyond the reach of any but the very best men, and may be described as being somewhat too difficult and elaborate.

There are obvious reasons why, as time goes on, the questions should become more difficult; still it would be interesting to trace the changes over some considerable period, so as to be able to explain how the Tripos examination has reached its present form. The changes must have been of a gradual character, because the traditions and customs of the examination have been faithfully transmitted from one set of examiners to the next. One can see, however, that if any particular person were to examine often, as has occasionally happened, or if several persons of like tastes were to examine together, we should find the questions displaying a particular bias. When this should occur, the studies of the candidates would receive the same bias, and particular branches of mathematics would thus be pushed for a time into undue importance. So much was this the case about the year 1864 that Sir G. Airy, when delivering the Rede lecture in the Senate House, went out of his way to denounce the excessive attention given in the University to certain branches of pure mathematics.

We can thus imagine the Tripos examination based upon the traditions of its predecessors, yet continuing to grow both in extent and difficulty, and with some of its features perhaps somewhat exaggerated. In 1873 a great change had to be made. The University, feeling it was not creditable to it that so little encouragement should be given to the higher branches, and especially to the great modern subjects of mathematical physics, determined that those subjects should be introduced into the Tripos examination. The additions thus made, besides considerable extensions in the subjects already existing, included, amongst others, Elliptic Functions, Electricity, Magnetism, and Heat.

It was thought that in thus extending the examination the students would have a choice of subjects, and that their course of study would thereby be rendered more interesting than it was before. It was certainly never intended that the burdens under which the Tripos candidate was already staggering, should be increased upon him. But how were these changes met on the part of the students and on the part of the teachers? The immediate result seemed to be that the best candidates attempted to know something of all the subjects. The examiners in 1874 were careful to watch for indications as to whether the candidates had devoted themselves to special groups, but they reported that there was no evidence to that effect. The University thereupon passed a Grace enacting that the number of questions in the higher subjects should be increased, the object being to supply a sufficient variety so that a candidate who had confined his studies to a limited group might reasonably expect plenty to occupy him in the examination. This provision has continued operative down to the present time, but it does not appear to have produced the salutary effect intended. There is much reason to fear that the best candidates still push their way through most of the subjects, whilst the next best struggle as far in the same direction as they can.

There is then a well-defined evil to be remedied. For no one can deem it a good education where the student is carried, necessarily with rapidity, over a variety of subjects, many of which he must therefore very imperfectly comprehend. What changes in the examination are proposed to the University as a remedy we will presently describe. Meanwhile let us glance at the position of the teachers in their relation to the new state of affairs.

It must be admitted that the great changes made in 1873 found the college lecturers unprepared. There were only one or two of them who ventured to expound the new subjects to college classes. The students were therefore compelled to depend upon the private tutors, and thenceforth the selection of groups became difficult, if not impracticable. The fact we have just mentioned was, in truth, a misfortune in more ways than one. For the new subjects, and, indeed, the higher subjects generally

Vol. xix.—No. 473

admit of being really well taught only by men specially devoted to them, which clearly the private tutors as a class could not very well be. The higher subjects must accordingly for some time be taught in an uncertain way, and meanwhile we are deprived of the evidence, which would have been useful in the present emergency, as to how the Cambridge system would work if these subjects were completely in the hands of the lecturers, as they should be.

As between college lecturers and private tutors we have some reason to hope that one effect of the introduction of the new subjects will be that the former will rise in importance and the latter will, at least relatively, decline. We wish to write nothing but good of the private tutors personally, but if that result should really take place we should regard it as a decided boon. There may be some cases in which private tuition may have merits of its own, but for the ordinary student to have a private tutor perpetually at his elbow when he meets with a difficulty is to give him the worst possible education. In like manner we do not admire the system of more than paternal supervision practised by many of the college tutors over their pupils, the natural effect of which is that the pupil is not allowed to act or to think for himself. He is perpetually asking and getting advice about very trifling matters, and receives a great amount of what is called individual attention on a variety of subjects. But though he may thus gain a little knowledge, if he ultimately learns habits of self-reliance he learns them from other sources.

If the system of private tuition could be done away with, and if more vigour could be instilled into the collegiate system of lecturing, so that complete and adequate courses of lectures could be given, there would be a healthier tone and spirit in the studies of the University, and we are convinced the students would learn more and learn better. In proof of this we may state that the most successful of the private tutors in mathematics really do what ought to be the work of the college lecturer; that is, they deliver lectures to their classes and examine written work for them. We may also state that in the department of classical studies most of the students depend solely upon the college lectures.

We have made these remarks because it seems to us that the Tripos examination is only one phase of the broader question of the whole system of mathematical teaching. Certain proposals will to-day be made to the University, and if these be carried the scheme of college lectures will have to be remodelled: if at the same time a new spirit and energy could be infused into them, it would be a good thing for Cambridge teaching.

The proposed alterations in the examination may be briefly described as follows:—The subjects are in the first place thrown into two grand divisions. On the one side there are what may be called the easier subjects, covering all the ground which a moderately good candidate, whether his tastes incline him towards analysis or physics, may be expected to take up. On the other side there are the higher subjects of pure mathematics and physics. It is proposed that those two divisions should constitute the subjects of two distinct examinations.

The examination in the first division will, as regards class lists, take the place of the present Tripos, that is, the results will be given in the old form of Wranglers, Senior Optimes, and Junior Optimes, arranged in order of merit. This examination will take place in the June of the third year of residence, and only the Wranglers will be permitted to take up the second examination.

The subjects of the second examination which will take place in the following January are subdivided into four groups, and the results upon them will be given in classes, the names in each class being this time arranged in alphabetical order. It will be possible to attain a first class by doing well in one or two groups.

Those who bear unqualified hostility to competitive examinations, especially in their intensified form, when they are followed by an order of merit, will probably be satisfied for the present, hoping that at some future time they will succeed in abolishing the order of merit entirely. There are others who approve of the proposed changes, and who yet think that when confined within reasonable bounds such competitions can do no harm and may do good. Undergraduate human nature being as it is, a good contest, even such as can be had in a Tripos examination, is rather enjoyable than otherwise, and brings out qualities which are worth reckoning for something. It is also a good thing that an undergraduate should learn to have a piece of hard work well done in a given time. What has to be seen to is that the competition does not react injuriously on the course of study. There are many reasons which commend the proposed changes in that connection, and to one or two of these we will now advert.

In the first place, the higher subjects are not suitable for purposes of examination, because the questions which are likely to be put on them require long work and probably much reflection. It is good, therefore, not only that these subjects should be studied leisurely, but that the element of hurry should be as far as possible excluded from an examination upon them. It is true that the last remark will apply also to the lower subjects, but we are to consider that the latter subjects which usually consist of a few simple principles, admitting of an almost infinite variety of simple applications, are in a measure the tools of the mathematician who ought to be well skilled and expert in their use.

Again, if there is to be strict competition it is as well that the area should be narrowed and that the combatants should meet one another on common ground. In the present state of things that cannot be, but under the proposed system it will be possible for a clever lad who has read but little when he enters the University, to hold his own against a competitor, his inferior, who does not begin his undergraduate course till he has been pushed, or has plodded on a good way towards his mathematical degree.

The opponents of the proposed changes affirm that the Tripos will lose its prestige, and that the students under the new system will entirely neglect the second examination. It seems sufficient, in answer to the first of these objections, to point out that the first examination will not be so insignificant either in extent or difficulty, as not to compare in those respects with the Tripos examination of forty or fifty years ago. And as to the best students neglecting the second part, that is a circumstance which seems very unlikely to occur, but the colleges will have the matter in their own hands, and it is to be expected they would be patriotic enough to refuse their fellowships and certainly their lectureships to students who had not distinguished themselves in both parts.

It is impossible to touch on all the points which suggest themselves in connection with this question, but we may point out in conclusion that the examination in Cambridge has to adapt itself to two classes of candidates, viz.: There is the class who may be called professed mathematicians, because they spend their lives in cultivating mathematical science and in teaching it to others, and there is the class who abandon their mathematics as soon as their undergraduate course has terminated. Of the former class we believe that their tastes and the necessities of their position will alike carry them beyond the subjects of the first examination. In the case of the second class, which is a large one, it is undoubtedly a wise thing to restrict their studies within the limits of the easier subjects. For under the present system, in their eagerness to secure good places they attempt subjects which are either beyond their powers or their opportunities, and so fail to gain the advantages which a strict mathematical training is supposed to afford.

"CRAM" BOOKS

Notes on Physiology, for the Use of Students Preparing for Examination. By Henry Ashby, M.B. (London: Longmans, Green and Co., 1878.)

THIS book, being a fairly creditable and careful specimen of its kind, seems to offer a fitting opportunity for denouncing the whole class of "cram" books of which it is a member. It purports to be notes on physiology, compiled originally, while the author was a demonstrator in the Liverpool School of Medicine, for the use of those students of the school who were preparing for the primary examination of the College of Surgeons; and it is confessedly based upon Foster's "Physiology" and the two chief anatomical text-books used in England. It is a small 18mo of about 230 pages, clearly printed in a large type, and it contains a number of condensed and dogmatic statements in all departments of physiology. It is, we rejoice to be able to say, written perspicuously and compiled with evident care. Most of what Mr. Ashby has read in Foster he has accurately digested and dogmatised. But though he has thus almost disarmed criticism as to his particular book, the book still remains infected with the vices of its class; it is a delusion and a snare to the student; and we heartily wish Mr. Ashby's talents had found a worthier object for their exercise. "Notes" are undoubtedly of the greatest value to a student—nay, they are indispensable, if he is to acquire a large view of his subject; but they are only valuable when the student has compiled them himself from the larger text-books, or, better still, from original memoirs, or when he has seen them digested and set down, so to speak, before his eyes by his teacher. Each of the sentences in his book Mr. Ashby doubtless could and would make the text of a lucid explanation in his lectures or demonstrations. He would lay before his hearers the different views of observers on different physiological questions, as he had learnt them, and, balancing the evidence, he would abstract for them a trustworthy judgment in a careful and concise statement: and the student who took down his notes, on re-reading them, would have the whole discussion refreshed in his mind with more or less vividness—would, in fact, have almost all the benefit of condensing the notes for himself. But when these concise statements or formulæ are put into the hands of students who have not been thus prepared for them, the case is wholly different. Aladdin has the lamp, indeed, but he can conjure up no powerful genii with it.

But if this were all we might be content to let books like this sink to their own level; their inutility would lead to their speedy death. But while the good student would never for a moment think of reading notes that he had not made himself, or if he did read those of another, would quickly find out the cause of their uselessness to any one but their author, the bad student is misled to believe that 230 small pages of fair-sized type contain the whole of the physiology that he needs; he looks through the list of contents and finds set down there almost every physiological fact and problem of which he has ever heard, and he naturally concludes that he has only to equip himself with this little book in order to cope with his examiner.

Mr. Ashby's book, admirable for the purposes of his own students, is useless or worse than useless to the students of any other teacher; published to the world, it is like a creature in an improper medium, and we are constrained to wish that, with all similar books, it may quickly meet the usual fate of creatures so circumstanced.

After this we need not say much about the book itself. On the whole it is well done. The histological sections are decidedly the weakest. The "ossification of bone" (p. 29), and the "development of tooth" (p. 107) might as well have been omitted altogether, as put in so meagrely. The extremely important histological researches of Heidenhain on the pancreas seem to be ignored on p. 16, where "probability" only is allowed to the elaborating functions of glandular epithelia. The pigment layer of the eye on p. 17 is assigned to the choroid coat instead of to the retina, and again on p. 194. No nucleus is given to striated muscular fibres on p. 81. On p. 179 Prof. Ferrier's name is put down at the end of a paragraph as if he were the prime authority for certain facts regarding the *corpora quadrigemina*, which we rather owe to Flourens, Longet, and Goltz. These errors are not of vital importance, and some of them have probably been due to inadvertence. But there are two more mistakes which are of greater weight, and show the danger of mere book-making. On p. 34, where the properties of muscle are discussed, we find that "On contraction . . . O is absorbed and CO_2 . . . given off." This is left unexplained here and in the rest of the book. What Mr. Ashby doubtless meant was that during contraction more arterial blood passes into muscle, and more O is taken up than during rest, while CO_2 is at the same time emitted; but, in the above unguarded way of statement, the fundamental fact of the independence of the actual absorption of O and disengagement of CO_2—a fact of the utmost moment in our conceptions of muscular work—would seem to be passed over. Again, on p. 168, under nervous conductivity, we have the curious statement that "the axis-cylinder probably conducts the impression, *the medullary sheath acting as a sort of insulator to prevent the currents from becoming mixed and confused*"—a physical explanation which no physiologist would now for a moment think of offering.